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3-D Maps From Commercial Satellites Guide G.I.'s in Iraq's Deadliest Urban Mazes

By ERIC LIPTON

WASHINGTON, Nov. 25 - The Army commanders in Iraq knew roughly where they wanted to position their men in Mosul, but first they had a few questions for Chief Warrant Officer Jason Feser. What alleys might turn into ambush routes? Were there any nearby minarets that could serve as sniper lairs? Where would he place troops to avoid possible friendly crossfire?

Taking soldiers into any urban environment is hazardous. But the Army has been using a new tool before going into Iraq's restive cities, like Mosul and Falluja, that helps officers answer critical questions and make their missions somewhat less unpredictable. The new weapon is called the Urban Tactical Planner, which combines advanced computer software tools with high-resolution imagery that is beamed down to earth from a new

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Advanced Map Reading

By layering military intelligence on top of commercial satellite images, Army planners are providing timely and detailed information about urban hazards to soldiers on the ground. Shown here is an image of Hilla, Iraq, with observations made by military engineers.

Wooded area could provide cover for an operation.

Highlighted building indicates a structure of interest. This one is likely to be public infrastructure, possibly a water treatment plant.



Lines of sight are limited in this neighborhood with its short, curved roads. Moving a significant force through here would be difficult because there is little space between buildings.

This building appears to be taller than most in this image and would be a useful vantage point to monitor roads. Tall structures can be used by snipers.

Major access routes are highlighted. Bridges can be critical choke points.

generation of commercial satellites. Mr. Feser was able to provide commanders with a three-dimensional virtual tour of a mazelike section of Mosul before the first troops from the First Brigade, 25th Infantry Division, and the Iraqi National Guard began capturing insurgents last month.

Not only did the commanders simulate flying overhead to practice air or ground approach routes, but by zooming down they also saw buildings and streets and spots where soldiers could assemble with some protection from sniper fire. The images are not clear enough to make out people. But schools, mosques and other important buildings were highlighted. Even ditches or other barriers that might slow down an approach were marked.

The Urban Tactical Planner is just one of a number of military and intelligence tools that use high-resolution commercial imagery. From relief efforts in Sudan, to mission planning for Air Force flights and Navy ship movements across the world, space-based imagery by private companies is now playing an essential role.

"It is the encyclopedia for minutia of Mosul," Mr. Feser said in a telephone interview from Iraq, after he used the imaging system to help his brigade prepare for its mission in Mosul. "Before what we had was a map with markers and acetate. It was like being a kindergartner with fat crayons."

Three high-resolution commercial satellites are now circling the earth, in orbits that range from 280 miles to 400 miles from the ground. The federal government has just committed \$1 billion to help two private companies launch two more satellites by 2007, to replace the current ones after their six- or seven-year life span ends.

Watching earth from space is nothing new. Since 1959, satellite photographs have been central to American military and intelligence operations, from monitoring Soviet missile sites to the claims - ultimately unproved - about unconventional weapons in Iraq. But during most of this history, the end product has been isolated overhead shots called "happy snaps," not computerized image mosaics found in the programs like the Urban Tactical Planner.

The unclassified source of the photographs is also critical, because the commercial images can be shared not only with United States partners - troops from the Iraqi National Guard or aid groups - but also with United States Army soldiers who often do not have security clearance. An image from a government spy satellite can be declassified, but the process is time-consuming. Even Iraqi war prisoners were shown some commercial images last year in an effort to locate hidden weapons.

"It allows you a level of detail and exactness that you are not going to get with any map," said Sgt. First Class Randy Arndt, who used the images during interrogations of Iraqi detainees.

As with any new technology, there have been more than a few serious setbacks. Four of the first high-resolution satellites built by private companies between 1997 and 2001 dropped into the ocean or burned up in the atmosphere because of launch failures.

For many potential clients in the United States - farmers, tax assessors or utilities, for example - aerial photos from low-flying airplanes still offer a better quality image. They also generally deliver pictures more quickly. The average turnaround time for a custom order by a commercial satellite is 4 to 10 days. But it often can take weeks, particularly if it is persistently cloudy in the target area. Small planes, meanwhile, can fly below the clouds and take much more detailed pictures.

The command center for the federal government's imaging effort is a sprawling, nearly windowless office complex outside Washington, the headquarters of the National Geospatial Intelligence Agency.

It traces its roots to 1803, when President Thomas Jefferson sent Lewis and Clark on an Army mission to map the just-purchased Louisiana Territory. The agency, a division of the Department of Defense, does not own any satellites. It is instead the primary government consumer of images collected by commercial satellites, as well as the National Reconnaissance Office, the supersecretive federal agency that builds and launches spy satellites. Geospatial Intelligence - GeoInt to insiders - involves taking individual images and adding multiple layers of data, including information from a super detailed interpretation of the picture, a traditional topographic map, weather reports, spies or soldiers in the field or intercepts of telephone calls or e-mail messages.

The commercial satellites now in orbit have about a two-foot resolution, meaning a black and white object two feet wide turns up as a single pixel. A card table covered with a white tablecloth would appear as a tiny dot; only when an object reaches the size of car - about three pixels - can viewers distinguish what it is. That is an enormous step forward from the first civilian satellite, launched in 1972, which had a resolution of about 260 feet. It is still not as sharp-eyed as the best spy satellites, believed to have a resolution of about six inches, according to Jeffrey T. Richelson, author of several books on intelligence.

But the images are still very useful. Early this year, for example, the State Department asked the geospatial agency to assess the extent of the ethnic violence in the Darfur region of western Sudan. Claims had already been made about the burning of more than two dozen villages. But the United States government wanted documentary proof. The images would not be of much use if they were classified, as the goal was to share this documentation with the world.

So on April 30, agency analysts ordered new images from Digital Globe, owner of one satellite, asking for scans within a 36,000 square mile region. It quickly turned up evidence of the violence: 129 of the 133 structures in one village had been destroyed, while 180 of the 240 structures in a second village were gone. In all, 2,351 destroyed dwellings were identified in the photographs, which were posted on a federal government

Internet site. The agency also used satellite images to examine refugee camp locations and help determine safe locations to drop food, said Paul Rabatin, who worked on the project.

Other government agencies are also relying on satellite images -particularly in operations outside the United States and Europe, where it is harder to find plane-based cameras. The demand has been strongest from the military, which has had trouble getting its own next generation of spy satellites into space.

The Air Force, for example, now considers digital images taken by private satellites to be an essential part of a computerized mission-planning system that is gradually replacing traditional paper-map rooms.

As with the Army's Urban Tactical Planner, the Air Force system, called Falcon View, superimposes data on the digital images. It provides information that pilots need, like details about no-strike zones, broadcast tower heights, airport locations, runway lengths or possible surface-to-air missile locations. The system runs on a laptop computer but is downloaded onto a cartridge that is part of the pilot's avionics system.

When the pilot is flying at high altitude, Falcon View acts like a map of the nation's interstate highways, showing the journey with lower resolution photographs or maps that portray swaths of the earth. But as the pilot approaches the ground - and the target - the image resolution seamlessly increases, until it is possible to clearly see individual buildings and streets.

"A planning process that would have taken hours before can now be done in minutes," said Maj. Paul Hastert, a C-130 pilot who helps distribute Falcon View, which was developed by the Georgia Institute of Technology. Moving the vast amount of data in the imaging systems to locations around the world has been perhaps the most difficult challenge.

During the conflict in Afghanistan in late 2001 and 2002, the Air Force used the United States mail to send cartons filled with CD's to pilots. The Air Force Combat Support Office set up what it called the Pony Express, delivering the CD's in person. Delays in creating and distributing the maps resulted in many missions being flown without up-to-date information, Air Force officials acknowledge.

Army officials cite similar difficulties. A brigade combat team in Iraq took 18 hours to move from Baquba to Najaf instead of the typical six hours, because maps had not been updated to reflect that a bridge had been knocked out, said Robert W. Burkhardt, director of the Army Corps office that is building the Urban Tactical Planner.

The Air Force has tried to speed the movement of the images from space to users by setting up its own network of portable ground stations that can download satellite images. The Army, Air Force and Geospatial Agency are buying portable computer hard drives

with superhigh capacity so they can deliver updated images in one piece, instead of in dozens, even hundreds of CD's.

Even with these improvements, the Air Force system still is not updated as often as commanders would like, said James G. Clark, who runs the Air Force Combat Support Office. More images are now being collected than the military can rapidly put to use.

"Data in Bethesda does you no good if you are in Afghanistan," Mr. Clark said, referring to the Geospatial Agency's headquarters. "We are trying to learn from our mistakes."